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01/15/03 JC901 U.S. PTO

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EL556128275US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)

☐ Additional inventors are being named on the _______ separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max)

Fuel Supply Method for Direct Methanol Fuel Cell (DMFC)

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City		State		ZIP	
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ENCLOSED APPLICATION PARTS (check all that apply)

☑ Specification Number of Pages 10
☑ Drawing(s) Number of Sheets 6
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.
☐ A check or money order is enclosed to cover the filing fees
☑ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 15-0610
☑ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($): $80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______________________

Respectfully submitted,

SIGNATURE Carl Oppedahl

Date 01/15/2003

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Docket Number: SNDN.P-002-PV

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Title of Invention

Fuel Supply Method for Direct Methanol Fuel Cell (DMFC)

Abstract

In a direct methanol fuel cell (DMFC), fuel efficiency is maintained by periodically adding a higher methanol concentration mixture through a cartridge into the primary fuel container. The cartridge replenishes methanol and partial water losses due to the consumption of fuel in the power generating process. The fuel replenishment mechanism is controlled through an electronics apparatus that monitors the power conversion process and is capable of predicting remaining operating capacity.

Technical Field of Invention

DFMCs generate electricity through decomposition of methanol into hydrogen ions and electrons. Hydrogen ions propagate through the proton exchange membrane into the cathode area, while electrons reach the cathode through a load providing electricity in the process. Electrons reaching the cathode area recombine with Hydrogen ions which in turn combine with oxygen supplied by the air to provide pure water.

BACKGROUND OF THE INVENTION

Direct Methanol Fuel Cells are comparatively small and potentially suitable to be used in small electronic appliances. Key for such an adoption is further miniaturization, reduction in cost as well as improvements in the performance of the cell.

This invention addresses some of the key performance issues relating to the effectiveness of the fuel usage as well as the ease of use by the consumer and the integration of the technology with power management methods employed in portable computer and electronic devices.

Details of invention

A description of the fuel storage apparatus to implement the fuel replenishment method.

A description of the apparatus to store a high concentration methanol mixture (described hereon as cartridge).

A mechanism is described that controls the opening and closure of the passage between the cartridge and the main fuel container in proportion to the output voltage of the cell.

An alternative mechanism is described that adjusts the methanol concentration in the main fuel container based on calculations of the remaining capacity of the cell.

A manual method that can be actuated by the user to force replenishment when there is not enough power left to drive the automatic replenishment.

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A method to calculate remaining electric energy in the cell based on electric current (load current) and cell voltage measurements (See fig 1)

The method in general of displaying the cell remaining capacity (smart cell).

The method in general of adjusting the fuel concentration based on information provided by the electronics on the remaining fuel capacity.

In situations where the cell voltage decreases below a critical threshold, (as determined from the cell output voltage), the destructive piercing of the cartridge in order to recover cell operation

Impact & Benefits

The DMFC fuel replenishment container (cartridge) can be discarded after it is used in order to be replaced by a new one. It is the view of the authors that this fuel replenishment method is the most convenient for the user, as it does not involve direct user contact with chemicals in order to refill the cell.

The obvious method is to provide cartridges with the correct methanol concentration to be used for a single load cycle.

This invention enables the use of the same cartridge for a much longer time, increasing the usage of the cell as well as reducing the cost of operating it.

Given the methanol concentration (solution of 3% typically) and the volume of the fuel, a theoretical calculation of the quantity of electricity that can be produced from a DMFC can be performed.

The actual performance of the cell however is affected by dynamic parameters such as cell temperature, ambient temperature, load condition, etc.. Effective determination of cell's capacity can be estimated accurately by taking into consideration all these operating parameters along with the fuel condition.

Figure 2 illustrates the effect of stirring the fuel mixture in the performance of the cell. The effect of stirring is attributed by the authors to the fact that concentration of methanol in the anode area is constantly reduced because of its decomposition into hydrogen and carbon dioxide. Stirring achieves homogenous concentration in the container including the anode area.

The conclusion is that even when the fuel has originally optimal methanol concentration it cannot maintain it in the anode area without such assistance.

A method is proposed to assist fuel circulation through a piezo-pump (or other means) in order to provide constantly maximum possible methanol concentration in the anode area.

The frequency of the stirring depends on the size and the shape of the main fuel container.

Implementation Examples

Figure 3 presents another implementation example of this invention. When a critical threshold is determined either by the cell voltage or by calculating the remaining electrical power, the system issues an alert to the user. The user subsequently removes SAFETY LOCK(7) and pushes PUSHING PIN(8).
As a result of this action a needle pierces the cartridge enabling the mixture of high methanol concentration fluid into the main container. As a result, the enriched fuel recovers the operation of the cell.

This method can be effective in implementations with a relatively small fuel canister, such as cellular phones. Using this method a single cartridge can double the power generating ability of the cell.

Figure 4 and 5 present other implementation examples of this invention. When the electronic apparatus detects a critical low condition (either by voltage measurement of by remaining capacity calculations) it actuates a mini-pump (7), forcing a determined amount of high methanol concentration fluid from the cartridge into the main fuel container.

Figure 5 highlights the operation of the mini-pump.

A microcontroller calculates cell remaining capacity based on cell voltage, temperature, etc., and determines the amount of time the pump has to be activated each time.

The MCU causes the piezo element to vibrate for a specified amount of time restoring the methanol concentration in the main container.

The duty-cycle of this operation is adjusted dynamically determined upon the volume of the main container and the calculated fuel concentration at each time.

Figure 6 shows actual measurements of an experiment based on the ideas of this invention. A small motor was used as a test load for the cell.

At point A, just prior to motor stopping, 2 cc of a 10% methanol solution was added and stirred into the remaining fluid of the main container.

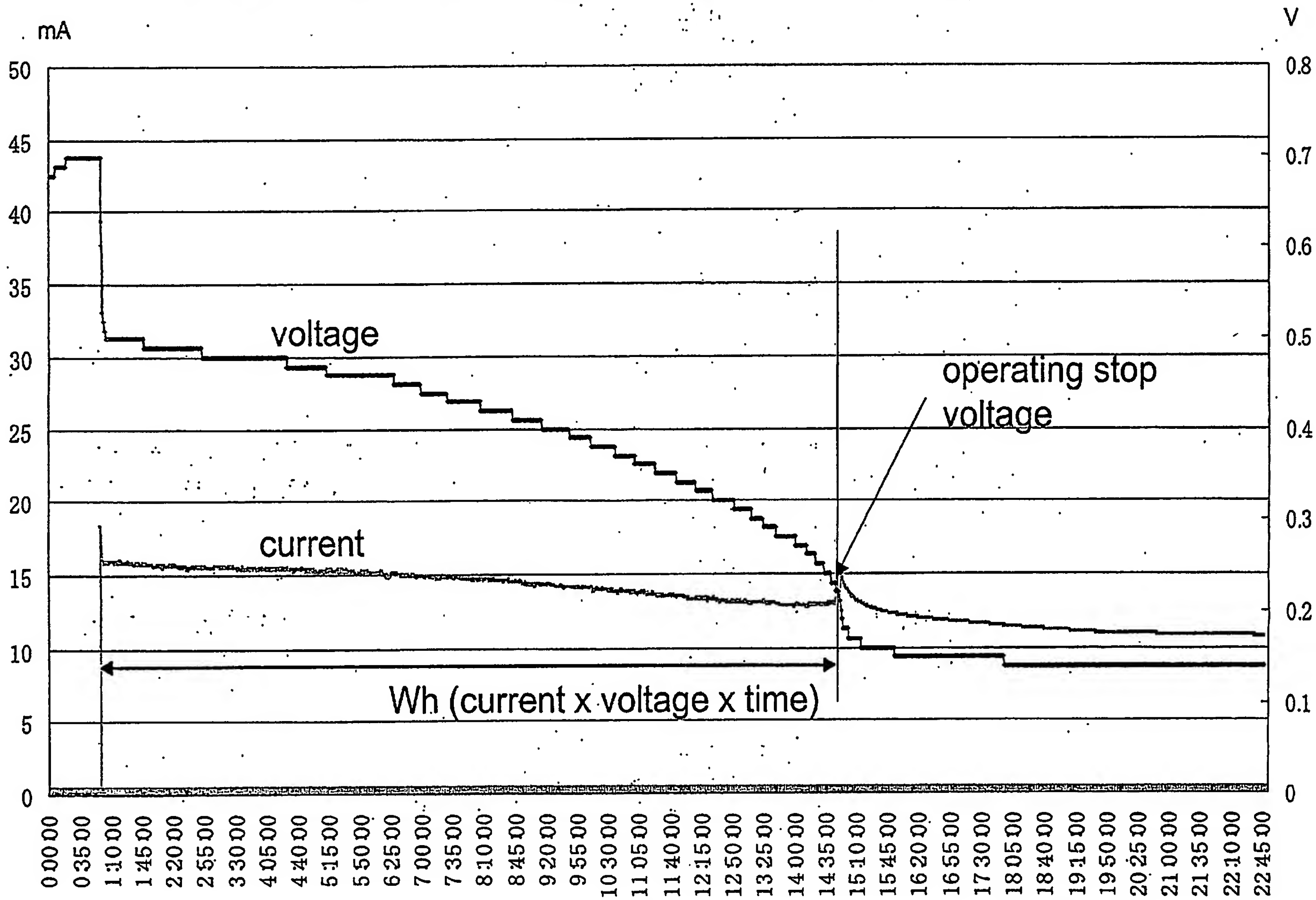
It should be noted that the determination of point A depends on the application and the load conditions. In addition the amount of fuel injection has to be determined accurately based on the volume of fluid in the main container, so the active fuel never exceeds the optimum concentration of 3%.

A higher than 3% concentration of active fuel will cause rapid deterioration in the platinum used as a catalyst as well as in the proton exchange membrane. The method described above prolongs the operation of the fuel cell while preserving at the same time the useful life of the cell itself.

Looking at Figure 6 we observe that the voltage of the cell recovers rapidly. This would not be the case if the replenishment fluid was not actively stirred into the main container. Subsequent measurements will show the cell recovery process without stirring.

It should be noted that in specific mobile applications such as cellular phones it may not be necessary to implement the micro pump mechanism because stirring occurs naturally as the user moves the equipment.

Characteristics of DMFC(3%)



 Confidential Fig 1

DMFC (3%) Effect of Fuel Stirring

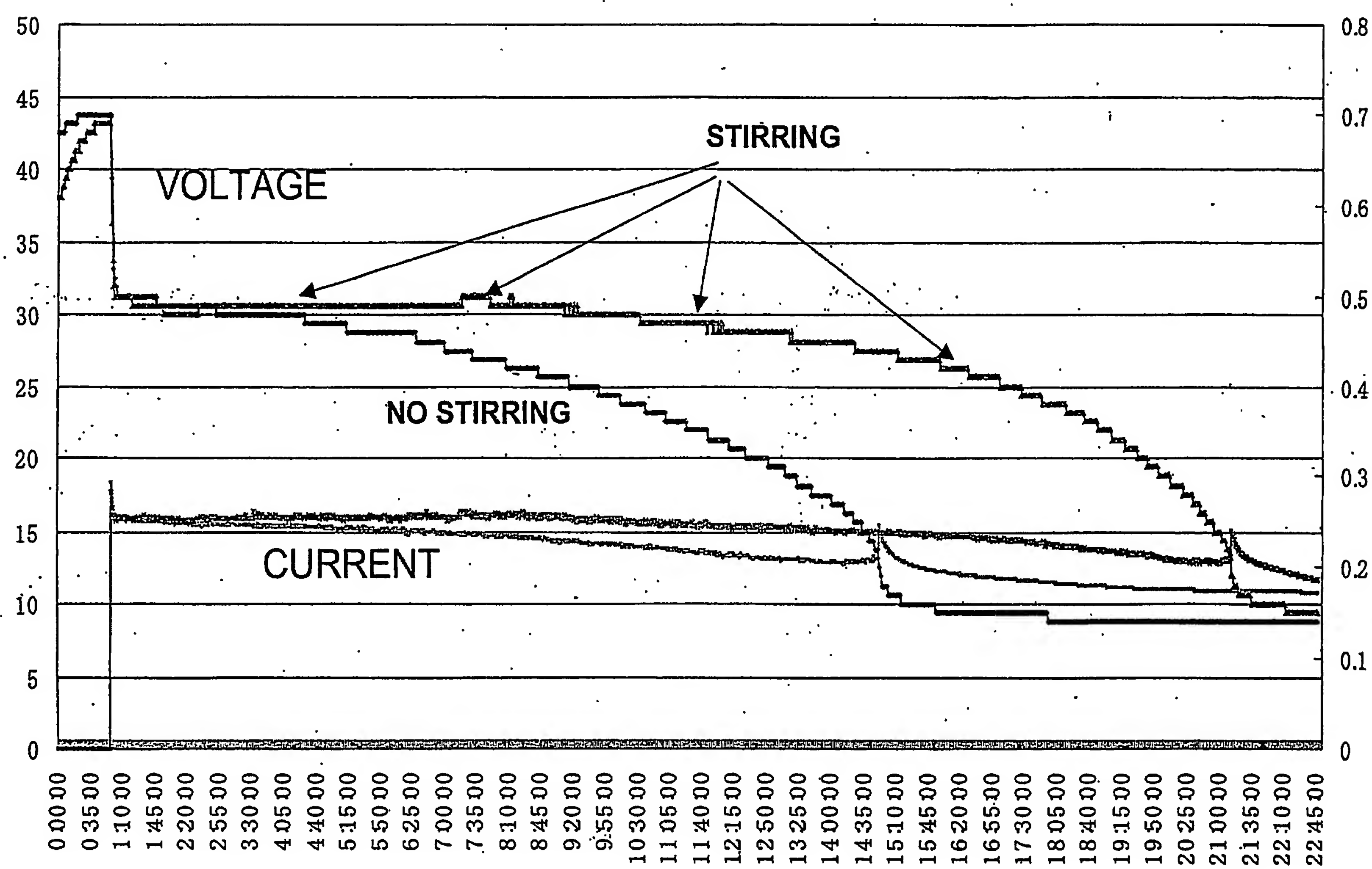


 Fig 2 Confidential

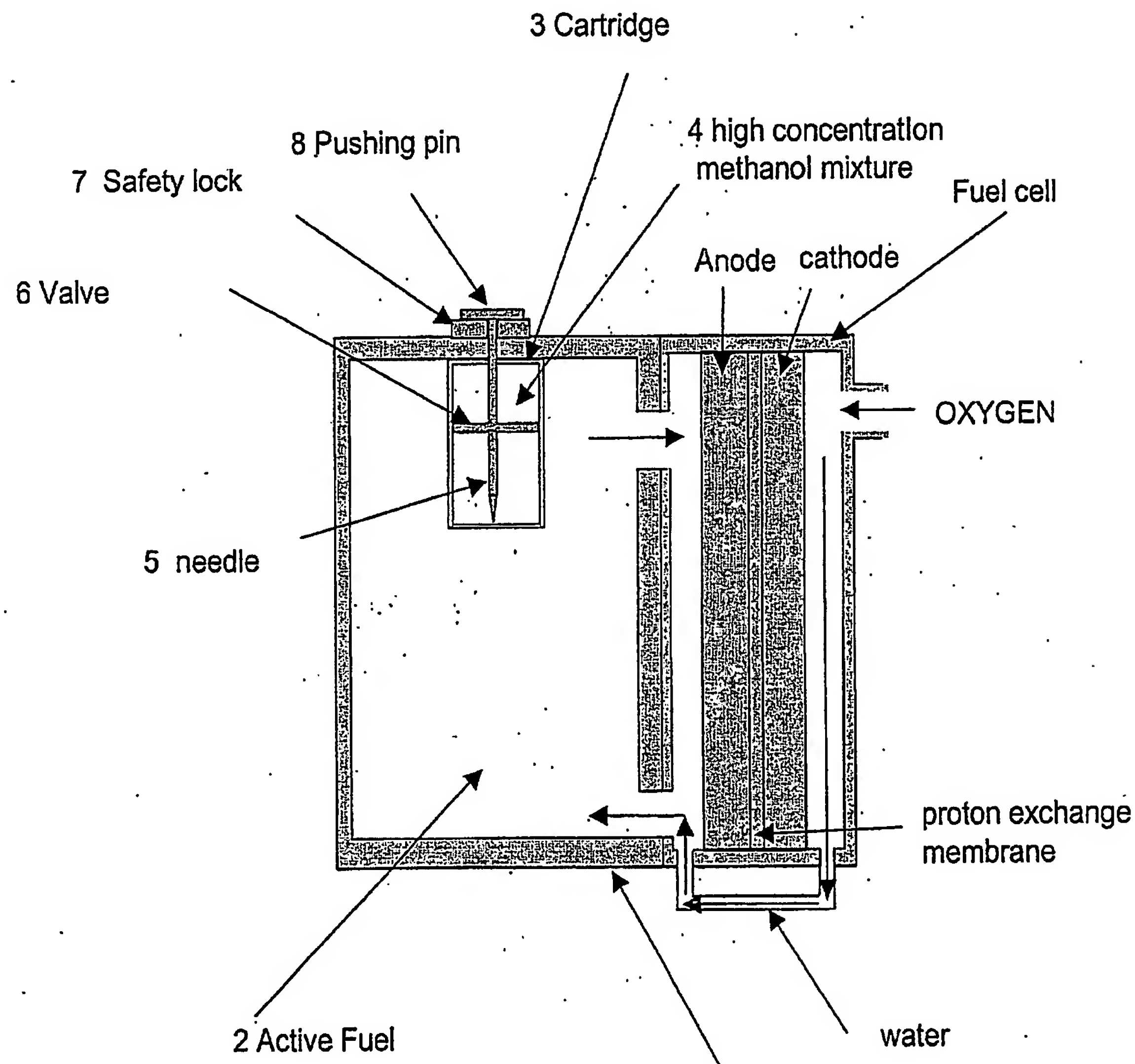

3 Cartridge
8 Pushing pin
7 Safety lock
4 high concentration
methanol mixture
Fuel cell
Anode
cathode
6 Valve
OXYGEN
5 needle
proton exchange
membrane
2 Active Fuel
water
1 Fuel container

Fig 4

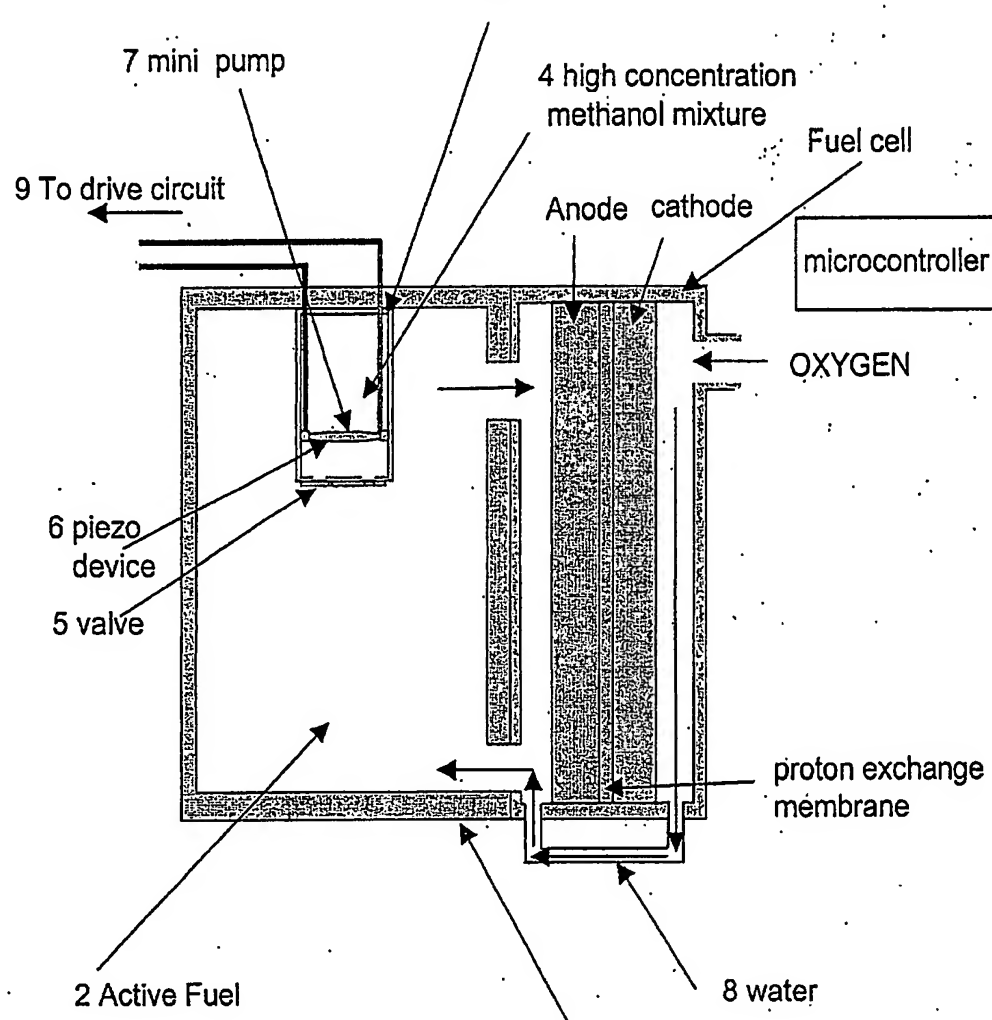

3 cartridge
7 mini pump
4 high concentration methanol mixture
Fuel cell
9 To drive circuit
Anode
cathode
OXYGEN
6 piezo device
5 valve
proton exchange membrane
2 Active Fuel
8 water
1 Fuel container

Fig 4

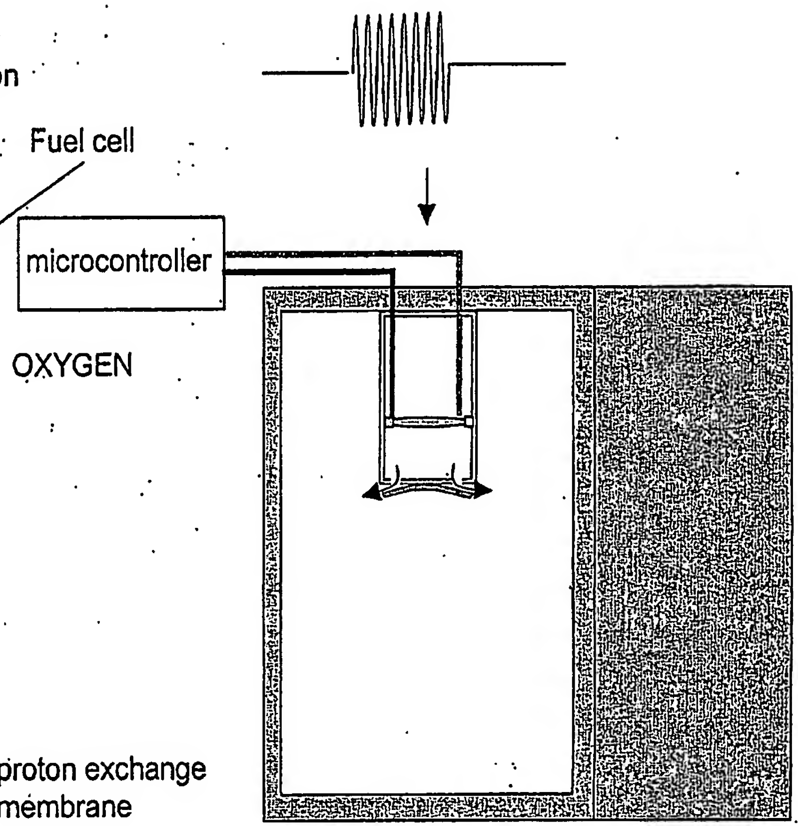

microcontroller

Fig 5

10% methanol mixture injection at 0.28V

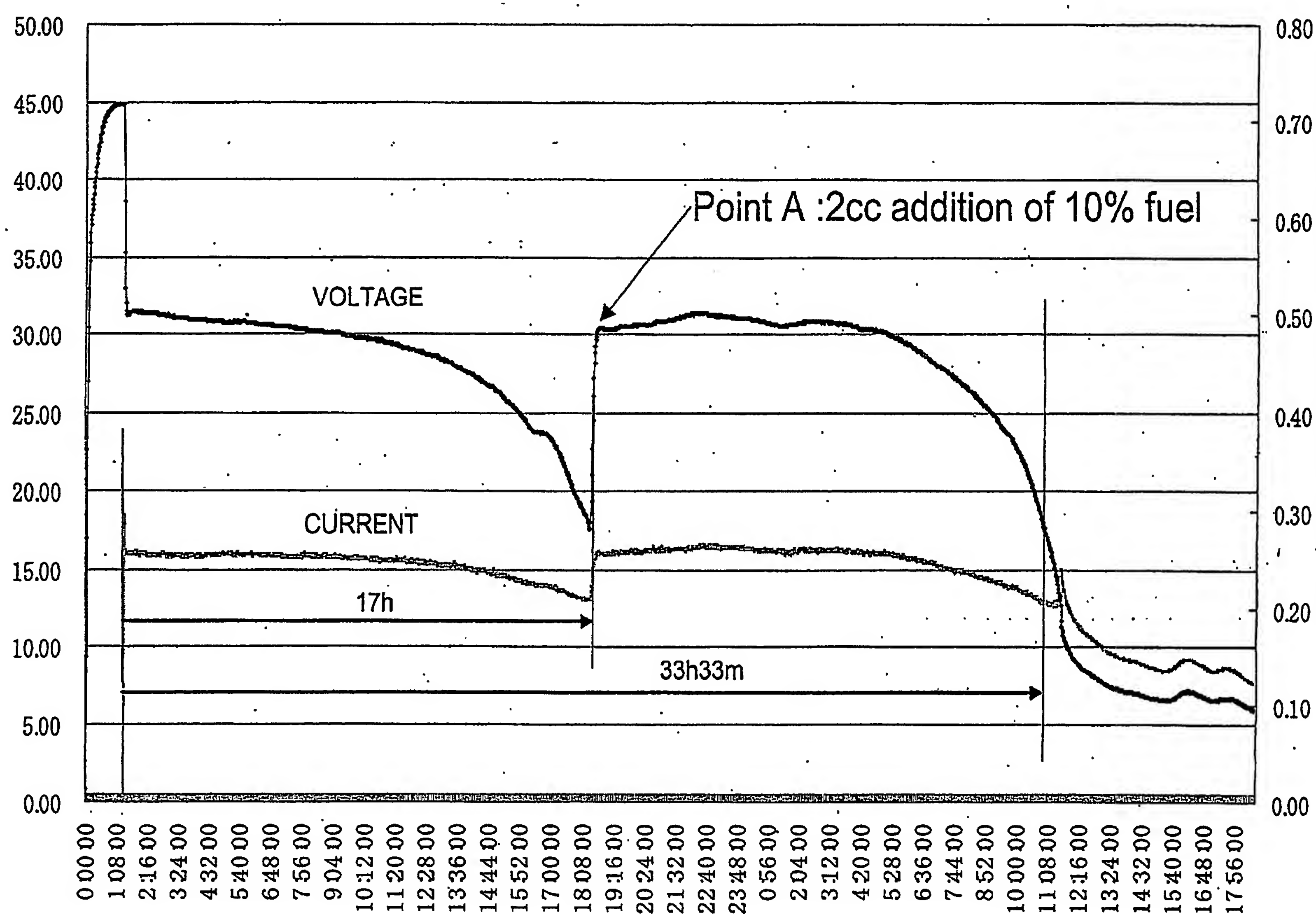


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Fig 6

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